Federal Aviation Administration

Airspace Management Handbook

METRICS

AIRSPACE MANAGEMENT HANDBOOK

METRICS

The Airspace management Handbook - Metrics has been prepared for the specialists in the field or the airspace design team who may have to initiate or participate in the process of making changes to the airspace structure. The field specialists may be working in the regional offices, an air route traffic control center (ARTCC), a terminal radar approach control (TRACON), or an air traffic control tower (ATCT). The airspace design team may be made up of personnel from the affected facilities, regional personnel, FAA headquarters personnel, and stakeholders. This handbook will also be provided to members of the Air Traffic services (ATS) offices at FAA Headquarters, as well as to the many stakeholders in the aviation community. Stakeholders are those who may be impacted by a change in the airspace structure, including airspace users (i.e., the major air carriers, regional carriers, general aviation, and the military), air traffic service providers (i.e., air traffic controllers, adjacent facilities, airport operators, and the military), and others such as local communities, special interest groups, and federal, state and local agencies.

This handbook identifies metrics according to the steps as defined in the Airspace Management Handbook. Figures summarizing metrics selectable for each appropriate step are included, as well as detailed information from operational data sources and analytical tools for calculation of the metrics.

Questions or suggestions concerning this handbook should be directed to:
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Office of Air Traffic Airspace Management
Planning and Analysis Division (ATA-200)
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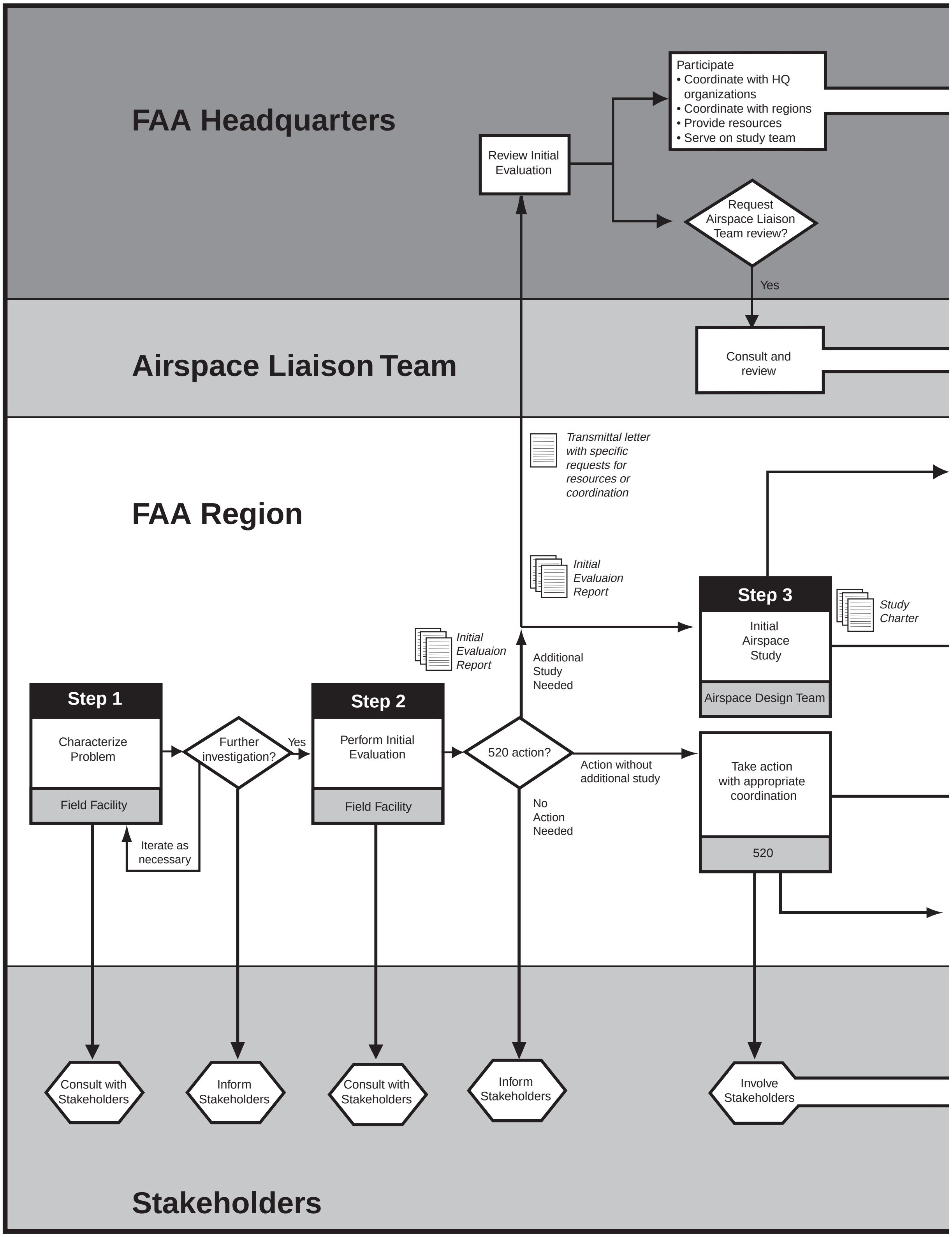
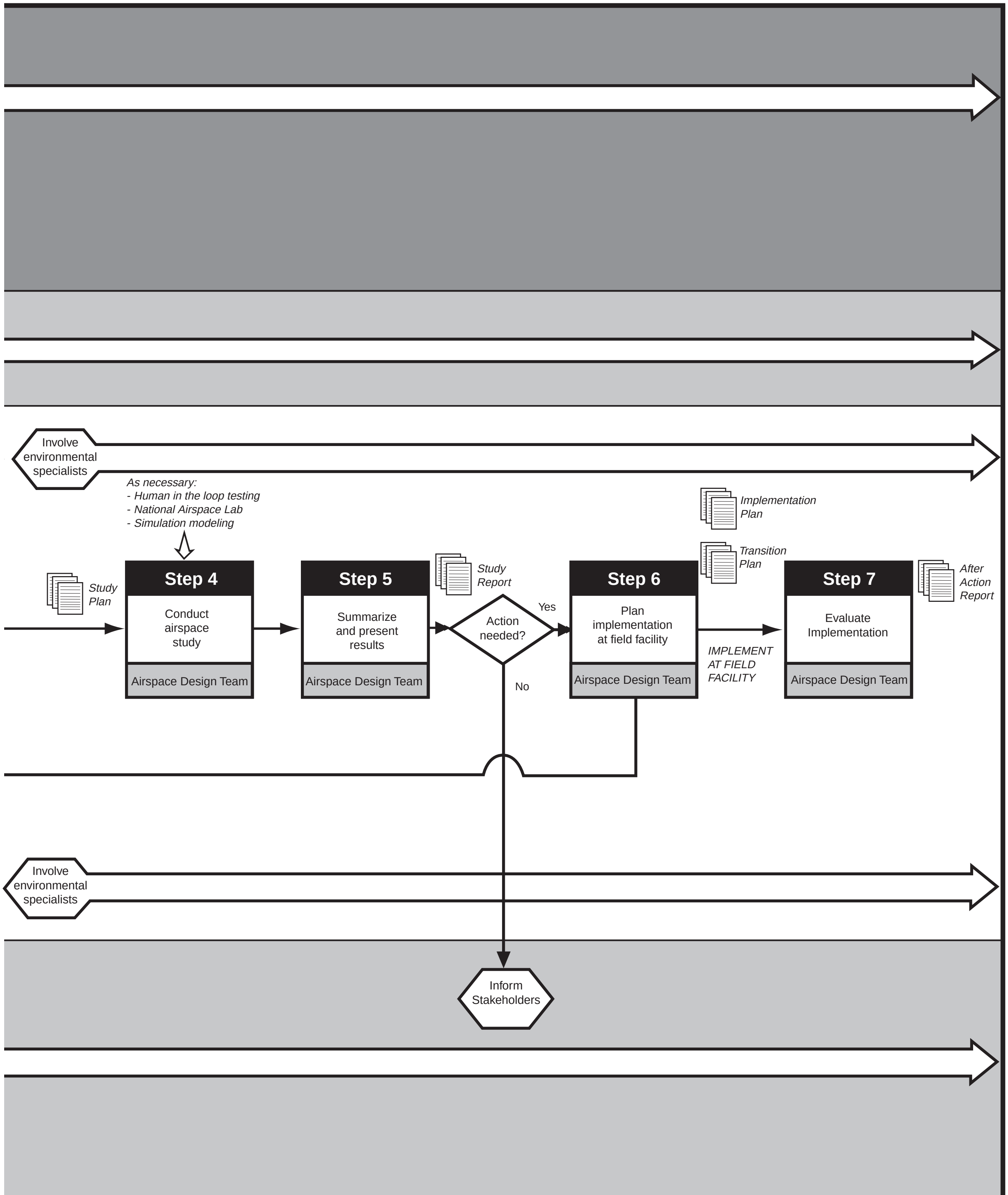

FAA Headquarters
Review Initial Evaluation
Participate
• Coordinate with HQ organizations
• Coordinate with regions
• Provide resources
• Serve on study team
Request Airspace Liaison Team review?
Yes
Airspace Liaison Team
Consult and review
FAA Region
Transmittal letter with specific requests for resources or coordination
Initial Evaluaion Report
Step 3
Initial Airspace Study
Airspace Design Team
Study Charter
Initial Evaluaion Report
Additional Study Needed
Step 1
Characterize Problem
Field Facility
Further investigation?
Yes
Step 2
Perform Initial Evaluation
Field Facility
520 action?
Action without additional study
Take action with appropriate coordination
520
No Action Needed
Iterate as necessary
Consult with Stakeholders
Inform Stakeholders
Consult with Stakeholders
Inform Stakeholders
Involve Stakeholders
Stakeholders



Involve environmental specialists
As necessary:
- Human in the loop testing
- National Airspace Lab
- Simulation modeling
Implementation Plan
Transition Plan
Study Plan
Step 4
Conduct airspace study
Airspace Design Team
Step 5
Summarize and present results
Airspace Design Team
Study Report
Action needed?
Yes
No
Step 6
Plan implementation at field facility
Airspace Design Team
IMPLEMENT AT FIELD FACILITY
Step 7
Evaluate Implementation
Airspace Design Team
After Action Report
Involve environmental specialists
Inform Stakeholders

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Introduction

1.1 Background

The Federal Aviation Administration (FAA) Airspace Management Handbook was prepared primarily for the specialists in the field who may have to initiate or participate in the process of making changes to the airspace structure. These specialists may be working in the regional offices, an Air Route Traffic Control Center (ARTCC), a terminal radar approach control (TRACON), or an air traffic control tower (ATCT). The handbook will also be provided to members of the Air Traffic Services (ATS) office at the FAA headquarters, as well as to the many stakeholders in the aviation community who participate in airspace studies.

The FAA Airspace Management Handbook describes a series of steps associated with the overall process of making proposed airspace changes to the airspace structure as shown in Figure 1-1.

- Step 1, when problems associated with airspace design or structure are characterized from within the FAA or by sources external to the FAA such as the National Airspace System (NAS) users, airport authorities, or communities.

- Step 2, when an initial evaluation is performed to determine whether a problem or issue identified with use of the NAS needs to be resolved through a change in the airspace structure.

- Step 3, when an airspace design team is formed, a charter is drafted, and a comprehensive study plan is developed.

- Step 4, when an airspace study is conducted. This study may consist of the steps from selecting and defining the metrics, identifying alternatives and associated scenarios, to analyzing the model outputs.

- Step 5, when the conclusions and recommendations derived from the analysis performed are documented in a formal study report.

- Step 6, when planning to implement recommended airspace changes is performed.

- Step 7, when airspace changes are evaluated after implementation to measure their success.

Metrics are proposed for Steps 1, 2, 4 and 7.

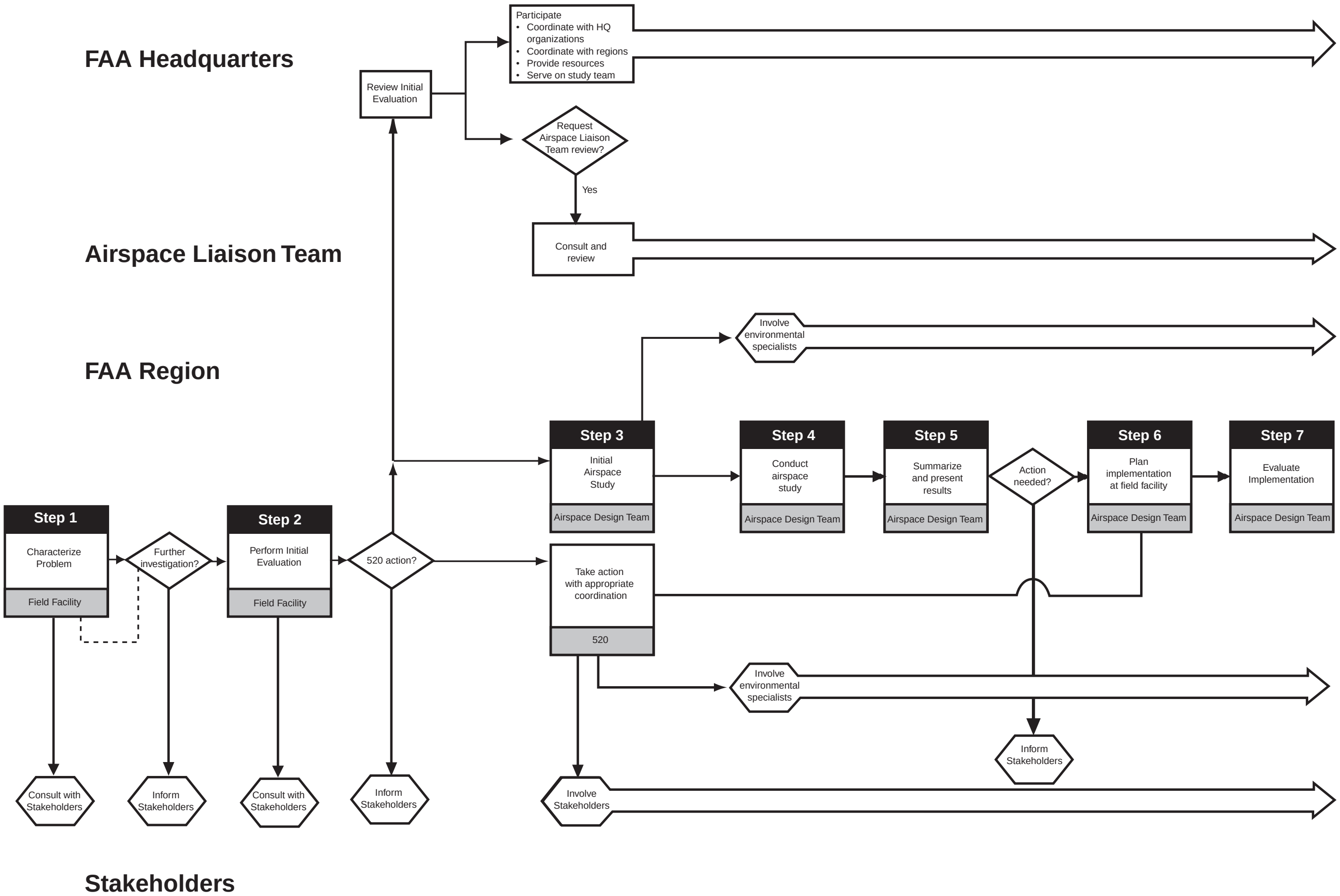

Figure 1-1. Airspace Management Handbook Steps

1.2 Purpose and Scope of this Document

This document identifies a core set of metrics for evaluating the benefits of airspace redesign. It is a companion to the FAA Airspace Management Handbook. The FAA Airspace Management Handbook provides a checklist and guidelines for a number of steps that should occur in the process of making changes to the airspace structure. Within a number of these steps, the field facility or the airspace design team will need to determine metrics to evaluate the impact of the proposed change. The intent of this document is to identify metrics to evaluate during the appropriate steps in this process.

It is expected that this document will be revised depending on the user's needs, and new metrics may also be added based on developments within the metrics research field. For example, currently this document does not contain metrics associated with airspace complexity. Metrics related to complexity are documented in a number of research papers and a limited survey of these papers are listed in the Bibliography of this document. In addition, there are some airspace tools that calculate metrics (such as Total Airspace and Airport Modeler [TAAM] and Reorganized Air Traffic Control [ATC] Mathematical Simulator [RAMS]) associated with system productivity and controller workload. While there is a general lack of consensus on system productivity metrics within the research community, this handbook has addressed system productivity by including metrics that are typically used and are available in both TAAM and RAMS. Based on further research, these metrics may be updated or revised.

1.3 Organization of this Document

This document identifies metrics to be used for conducting an airspace redesign. The metrics should be used when characterizing a problem and/or performing an evaluation as identified in the FAA Airspace Management Handbook. Metrics are identified for each applicable step in the handbook.

- Section 2 contains metrics applicable to Steps 1 (Characterize Problem) and 2 (Perform Initial Evaluation).
- Section 3 contains metrics applicable to Step 4 (Conduct Airspace Study).
- Section 4 contains metrics applicable to Step 7 (Evaluate Implementation).
- The glossary contains an acronym list.

1.4 How to Use this Document

These subsections provide the terminology and roadmaps to a set of metrics that have proven to be useful in previous airspace studies and analysis. This document does not preclude the use of additional metrics for assessing the extent to which a problem exists.

1.4.1 Terminology

Definitions and examples are provided for a number of terms used in this document.

1.4.1.1 Performance Outcome

A performance outcome is a system performance measure that reflect ATS' overall performance across all services that it provides. The ATS Air Traffic Performance Plan outcomes addressed in this document are:

1. Increase System Safety
2. Decrease System Delay
3. Increase System Flexibility
4. Increase System Predictability
5. Increase User Access
7. Increase Productivity.

This document does not address outcomes 6, Improve System Delivery by Increasing the Availability of Critical Systems and 8, Create a Model Work Environment.

1.4.1.2 Indicator

An indicator identifies the aspect of the NAS performance of concern that is used to help the analyst to select a metric. Indicators addressed in this paper are:

1. System Safety - the ability to maintain standards that define spacing distances between multiple aircraft, aircraft and other physical structures, and aircraft and airspace,
2. System Delay/Efficiency: when an activity does not occur within the planned, expected or scheduled time, and fuel efficiency for a given flight,
3. System Flexibility - the ability of the system to permit users to adapt their operations to changing conditions,
4. System Predictability - the variation in the system as experienced by the user,
5. User Access - the ability of the users to access classes of airspace,
6. System Productivity - the aviation activity associated with the system,

7. System Capacity - the ability of the system to support the number of users entering and exiting the system, and
8. Environmental Impact - the level of noise associated with an airspace or route.

Indicators 1 through 6 are derived from ATS Performance Plan outcomes. For each indicator, there are one or more metrics associated with it. As described in the FFP1 Performance Metrics, note that it may not always be possible to improve flexibility, predictability, access and on-time performance simultaneously. There may be times when it will be necessary to trade off one against another. The tradeoffs will depend on user needs.

1.4.1.3 Metric

A metric provides a measure for the indicator. Metrics are measurements defined by the user in terms of time, distance, number of operations or other factors. Metrics should be measurable via operational data or via modeling tools. For example, an arrival delay metric can be measured through determining the arrival time from Airline Service Quality Performance (ASQP) data and from determining the scheduled arrival time from the Official Airline Guide (OAG). Arrival delay can also be measured within modeling tools such as TAAM, RAMS and SIMMOD.

1.4.1.4 Metric Description

The metric description describes how the metric is measured. Note that a number of the metrics are based on the average of a value. The statistical method to determine the average is left up to the analyst to determine based on the integrity of the data available.

1.4.2 Metrics Roadmaps

For each of the applicable steps, there is a figure that shows a roadmap to the indicators and metrics. For example, the indicators and metrics associated with Step 4 are shown in Figure 1-2. The metrics will be selected based on the indicators addressed by the airspace study. For example, if the study is addressing system safety, then the metrics Convergence Pairs and Average Time to Converge should be selected and evaluated.

For each figure, there is additional detailed information concerning the metrics in a series of tables based on the applicable indicators. The table format used throughout the document for each particular step is shown in Table 1-1. For each applicable indicator, there will be one or more metrics. For each metric, there will be a detailed definition, and example data sources or analytical tools that can be used to measure the metric.

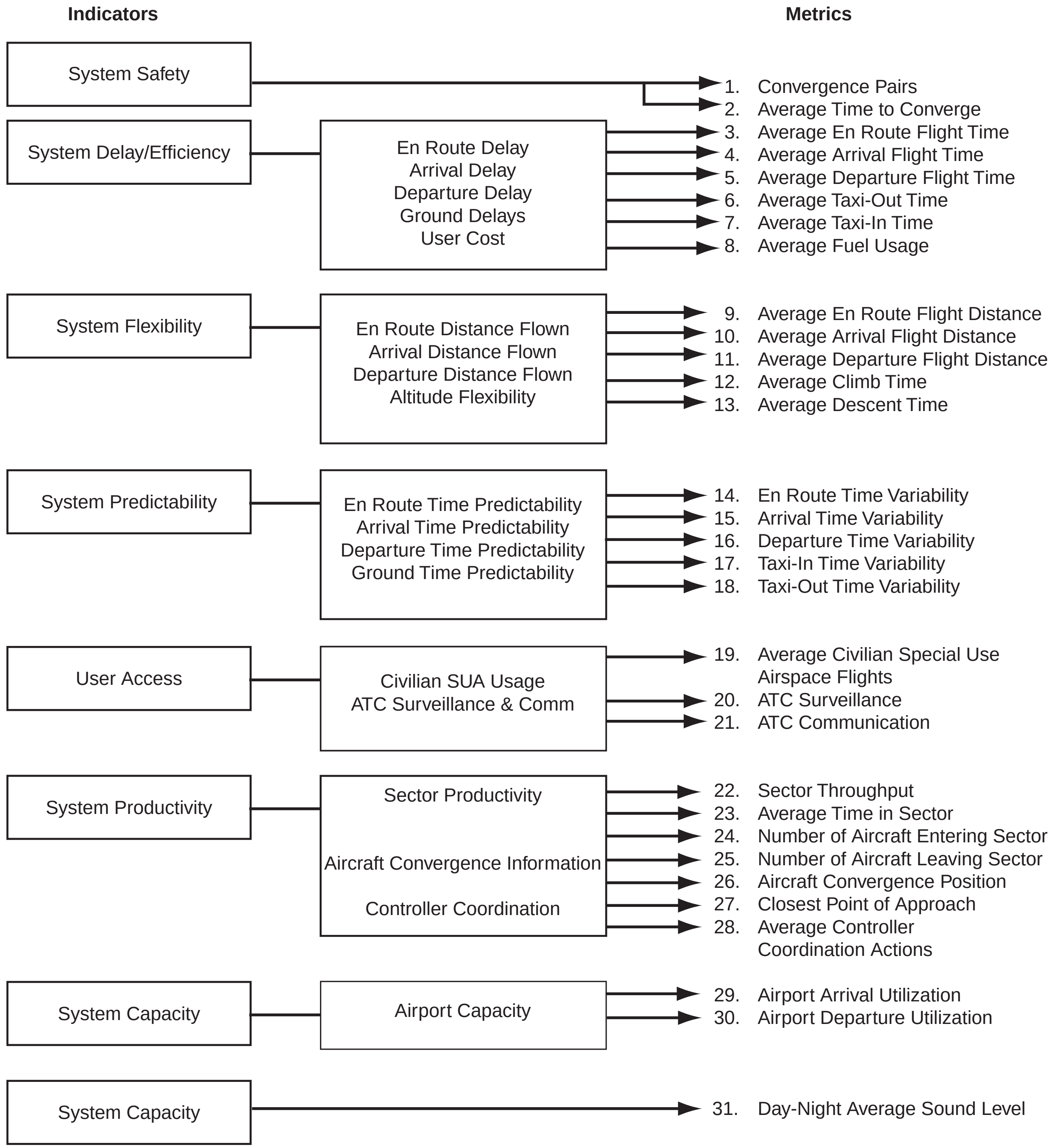

Figure 1-2. Step 4 Metrics

Table 1-1. Example Metrics Table

Indicator	Metric	Definition	Example Data Sources or Analytical Tools

The *example data sources or analytical tools* column in Table 1-1 provides examples from operational and analytical tools that provide a means to measure the values of the metrics based on the airspace change. For steps 1, 2 and 7, the metrics are measured from operational data and this column will show fields from example data sources to measure the metric. For step 4, the metrics are measured via analytical tools and this column will show output files from example analytical tools to measure the metric.

The example data sources include:

- Final Operational Error/Deviation Reports. Order FAA 7210.3R, Facility Operation and Administration, provides information concerning reporting of operational errors and deviations. This information can provide an indication of the current level of safety associated with a specific airspace, and may indicate a sector that should be evaluated for possible redesign to maintain a safe environment.

- ASQP data includes the scheduled and actual departure and arrival times of each flight of reporting airlines. The data collection is required by 14 CFR (Code of Federal Regulations) Part 234. In general, carriers with at least one percent of domestic schedule service passenger revenues are required to report data for flights involving any airport in the 48 contiguous states that accounts for at least one percent or more of the domestic scheduled service passenger emplanements.

- Automated Radar Terminal System (ARTS) provides track information on flights within a 60 nautical mile radius. Position reports are provided approximately every five seconds and include both Instrument Flight Rules (IFR) and Visual Flight Rules (VFR) traffic.

- System Analysis Recording (SAR) provides all non-voice information including radar reports within the ARTCC and flight plan messages.

- The OAG contains information about domestic and international scheduled air carrier and air taxi flights. The information includes the carrier, departure/arrival airports, local and coordinated universal time (UTC) departure and arrival times, and days of service.

- Air Traffic Control System Command Center (ATCSCC) or facility logs typically include the airport arrival rate (AAR) and airport departure rate (ADR) information. These AARs and ADRs represent the maximum hourly arrival and departure rates for a specific airport for a specific date and time. These rates are reported from the facility and take into account the airport's configuration and weather conditions.

- Enhanced Traffic Management System (ETMS) is a data access system that provides map data, aircraft situation data, monitor/alert data, and weather data. Aircraft Situation Data Host Z messages include flight plan amendment (AF), arrival (AZ), departure (DZ), flight plan information (FZ), cancellation (RZ), track update (TZ), and boundary crossing (UZ).

- Airport Demand List (ADL) is the data product that drives the FAA ATCSCC Collaborative Technology Tested (CTT) Flight Schedule Monitor (FSM) and the historical Collaborative Decision Making (CDM) Ground Delay Program Enhancements prototype operations. The ADL is primarily composed of data extracted from the CDM hub site databases, which are maintained with a combination of OAG data, airline-provided flight data messages, NAS messages generated by the ATC system, and issued ground delays.

Examples of how these metrics are measured from analytical tools are also provided for:

- TAAM, a software tool for the modeling of aircraft traffic, both en route, terminal, and on the airport ground,
- RAMS, a discrete-event simulation software package for analysis of airspace structure,
- SIMMOD, an airport airspace simulation model, can be used to model airspace and airport systems,
- Sector Design Analysis Tool (SDAT), an automated tool to assist in the design of airspace,
- ArcView, a tool for displaying and analyzing NAS performance and weather data on U.S. maps,
- Radio Line-of-Sight Coverage Mapping System (RACOMS), a tool to produce, display and plot maps showing the composite line-of-sight coverage provided by one or more radio sites located in the US or elsewhere,
- Integrated Noise Model (INM), Order FAA 7210.3K, a tool to determine the predicted noise impact in the vicinity of an airport,
- Noise Integrated Routing System (NIRS), a tool to determine the predicted noise impact in the vicinity of multiple airports, and
- Air Traffic Noise Screening Model (ATNS) provides guidance to air traffic managers in identifying air traffic changes that will increase aircraft noise exposure and the possible need for an Environment Assessment based on user-provided Stage 2 and 3 operation and community information.

For most of these tools, a file and field reference that will provide the value of a metric is shown. Note that in some cases where no tool reference is provided, the metric may still be derived from other output data (such as latitude and longitude information). These tool examples show cases where the metric can be easily measured.

Once metrics are selected, an analyst may have to specify a representative time period or specific airspace boundaries associated with an airspace change. For example, an arrival delay metric could be used to identify a problem that occurs either during a specified daily arrival push and therefore should be calculated for small intervals such as hourly, or seasonally. Additionally, an analyst will calculate the metric based on the airspace change. For instance, the airspace change may be associated with a different arrival fix, or different sector boundaries.

Step 1 (Characterize Problem) and Step 2 (Perform Initial Evaluation) Metrics

2.1 Introduction

Figure 2-1 shows a roadmap to the Step 1 and Step 2 metrics to be used when characterizing a problem and/or performing an evaluation as identified by the FAA Airspace Management Handbook. This list does not preclude the use of additional metrics for assessing the extent to which a problem exists. The indicators identify the aspect of the NAS performance of concern and are used to help the analyst to select a metric. These operationally related metrics should be measurable by information available to the field facility or other sources. While examples of data sources are provided for the metrics, depending on the facility data resources, other sources may be equally suitable and used.

As described in the handbook, problem characterization may be an iterative process, with the possibility that any new investigation could open additional questions about the nature and extent of the problem. Step 1, problem characterization, leads naturally to Step 2, initial evaluation of the problem. In some cases, the initial evaluation can also have implications for problem identification. Because these two steps may be intertwined in terms of identifying and evaluating the problem, metrics are provided for both steps.

When conducting an airspace assessment, the analyst will choose among the listed metrics based on the nature of the anticipated problem as identified by the indicator. For example if an analyst is trying to quantify the airspace problem that manifests itself in terms of arrival delays, the metrics grouped under the indicator System Delay/Efficiency (i.e., metrics 5 and 6) should be used. The use of additional metrics grouped under other indicators (e.g., System Flexibility) is left to the analyst's discretion.

Once metrics are selected, an analyst may have to specify a representative time period. For example, an arrival delay metric could be used to identify a problem that occurs either during a specific daily arrival push and therefore should be calculated for small intervals such as hourly or seasonally and therefore could be calculated on a monthly basis. Additionally an analyst may want to calculate a metric such as actual arrival delays for various factors such as arrival fix. Details concerning these metrics are provided in the following subsections.

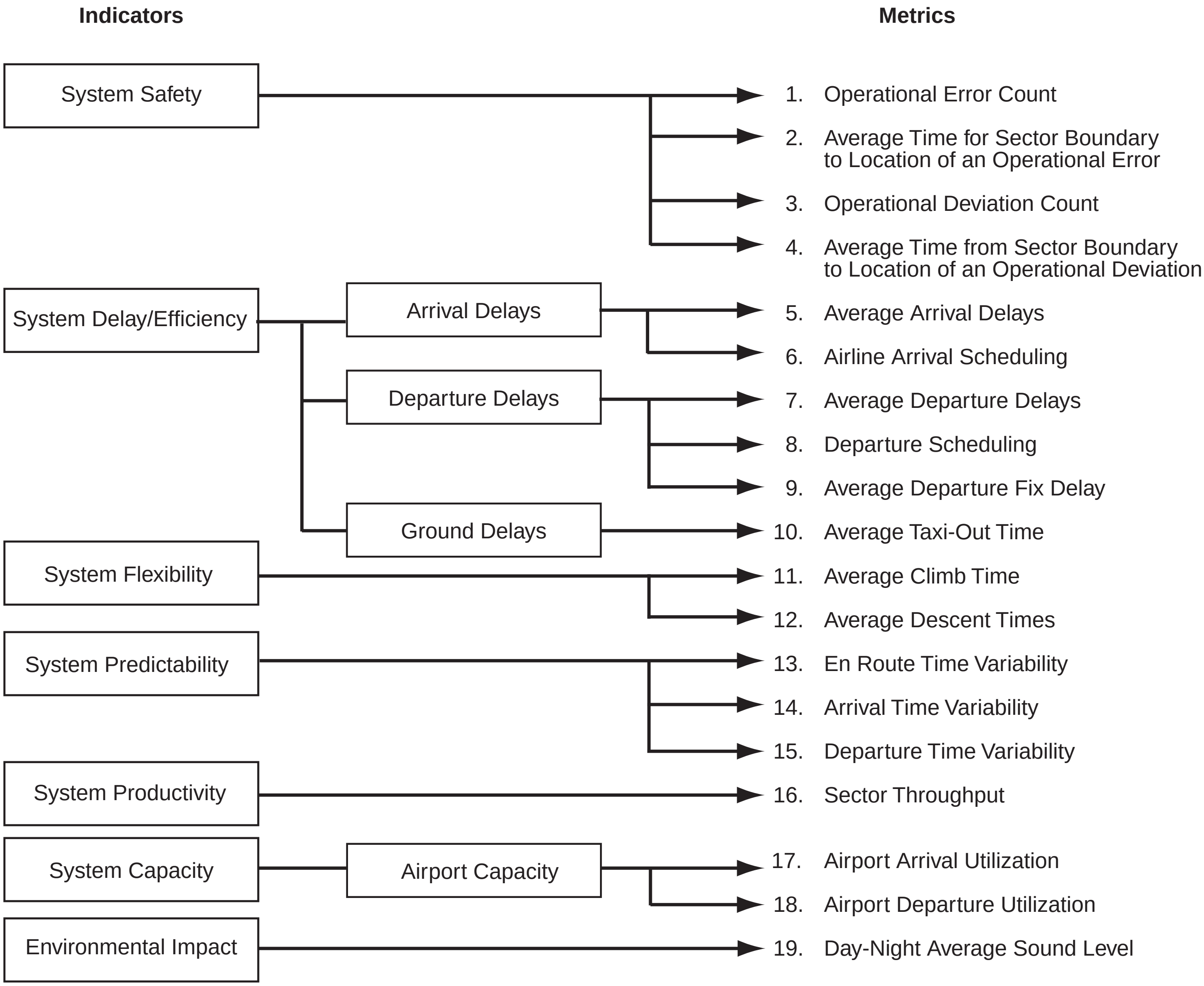

Figure 2-1. Step 1 and 2 Metrics

2.2 System Safety

These metrics examine the number of operational errors or deviations and the time from an aircraft crossing into a sector to the time that an operational error or deviation error occurs. As defined in Air Traffic Quality Assurance (7210.56A), an operational error occurs when:

- Less than the applicable separation minimum results between two or more aircraft, or between an aircraft and terrain or obstacles, or
- An aircraft lands or departs on a runway closed to aircraft operations after receiving air traffic authorization.

When an aircraft penetrates airspace that has not been pre-coordinated for that aircraft's use, an operational deviation occurs. An operational deviation occurs when:

- Less than the applicable separation minimum existed between an aircraft and adjacent airspace without prior approval, or
- An aircraft penetrated airspace that was delegated to another position of operation or another facility at an altitude or route contrary to the altitude or route requested and approved in direction coordination or as specified in a letter of agreement (LOA), pre-coordination, or internal procedure, or
- An aircraft, vehicle, equipment, or personnel encroached upon a landing area that was delegated to another position of operation without prior coordination and approval.

An operational error or deviation is recorded in facility records as per Final Operational Error/ Deviation Reports, Order FAA 7210.3R. These metrics can be used to indicate the current level of safety associated with a specific airspace, and may indicate a sector that should be evaluated for possible redesign to maintain a safe environment.

Table 2-1. Steps 1 and 2 Operational Errors and Deviation Metrics

Indicator	Metric	Definition	Example Data Sources or Analytical Tools
System Delay	1. Operational Error Count	Number of operational errors per representative time period per sector of applicable airspace.	Facility records as per Final Operational Error/ Deviation Reports FAA 7210.3 ARTS/SAR (Operational Errors) Track Position Reports
	2. Average Time from Sector Boundary to Operational Error	The average time from an aircraft crossing a sector boundary to the location of an operational error.	ETMS Message Types TZ (Track Update) ARTS/SAR (Sector Time to Operational Error) Track Position Reports
	3. Operational Deviation Count	Number of operational deviations per representative time period per sector of applicable airspace.	Facility records as per Final Operational Error/ Deviation Reports FAA 7210.3 ARTS/SAR (Operational Deviations) Track Position Reports
	4. Average Time from Sector Boundary to Location of Operational Deviation	The average time from an aircraft crossing a sector boundary to the location of an operational deviation.	ETMS Message Types TZ (Track Update) ARTS/SAR (Sector Time to Operational Deviation) Track Position Reports

2.3 System Delay/Efficiency

Delay is categorized here as arrival, departure or ground delays associated with a particular airport. Efficiency is categorized as fuel efficiency in terms of average fuel usage. Note that reduction in system delay does not necessarily imply a reduction in fuel usage or flight distances. Depending on the airspace design and airline practices, an airspace change that reduces system delay may increase fuel usage and/or flight distances.

2.3.1 Arrival Delays

These metrics indicate whether there are arrival delays associated with an airport. If significant delays are observed then the Airline Arrival Scheduling metric is useful to determine whether the delays are associated with airline over scheduling, or an airspace problem.

Table 2-2. Steps 1 and 2 Arrival Delay Metrics

Indicator	Metric	Definition	Example Data Sources or Analytical Tools
System Delay	5. Average Arrival Delays	Average arrival delay (difference between the actual arrival time and the scheduled arrival time) in minutes for representative time period.	ASQP Fields (Actual Arrival Time, Scheduled Arrival Time) Field 14 Actual Arrival Time Field 13 OAG Arrival Time ADL Flight Data (Actual Arrival Time, Scheduled Arrival Time) 12. AETA Actual Time of Arrival 28. LRTD Airline runway Time of Arrival 16. SGTD Scheduled Gate Time of Arrival
	6. Airline Arrival Scheduling	Difference of airport capacity versus scheduled arrival demand for a representative time period.	OAG Fields (Scheduled Arrival Demand) ARRIVE Arrival Airport ARRTIME Arrival Local Time FREQ Days of Service ATCSCC or Facility Log Fields (Airport Capacity) AAR

2.3.2 Departure Delays

These metrics indicate whether there are departure delays associated with an airport. If significant delays are observed, then the Airline Arrival Scheduling metric is useful to determine whether the delays are associated with airline over scheduling, or an airspace problem. The delays associated with a particular fix may also be measured to focus in further on the airspace problem.

2.3.3 Ground Delays

Trends and the variability of this metric over time indicates whether there are long ground delays associated with an airport.

Table 2-3. Steps 1 and 2 Departure Delay Metrics

Indicator	Metric	Definition	Example Data Sources or Analytical Tools
System Delay	7. Average Departure Delays	Average departure delays (difference between the actual departure time and the scheduled departure time) in minutes for a representative time period.	ASQP Fields (Actual Departure Time, Scheduled Departure Time) Field 9 OAG Departure Time Field 11 Actual Departure Time ADL Flight Data (Actual Departure Time, Scheduled Departure Time) 11. AETD Actual Time of Departure 27. LRTD Airline runway Time of Departure 15. SGTD Scheduled Gate Time of Departure
	8. Airline Departure Scheduling	Difference of airport capacity versus scheduled departure demand for a representative time period.	OAG Fields (Scheduled Departure Demand) LEAVE Departure Airport Code LIVETIME Departure Local Time FREQ Days of Service ATCSCC or Facility Log Fields (Airport Capacity) ADR
	9. Average Departure Fix Delay	Average difference of actual departure time with the time the flight is acquired by En Route radar over each departure fix associated with an airport for a representative time period.	ASQP Field (Actual Departure Time) Field 9 OAG Departure Time Field 11 Actual Departure Time ETMS Message Types FZ Project Departure Time DZ (Departure) (Actual Departure Time) TZ (Track Update) (Time aircraft is over departure fix) ARTS/SAR (Time aircraft is over departure fix) Track Position Reports ADL Flight Data (Actual Departure Time) 13. AETD Actual Time of Departure

Table 2-4. Steps 1 and 2 Ground Delay Metrics

Indicator	Metric	Definition	Example Data Sources or Analytical Tools
System Delay	10. Average Taxi-Out Times	Average taxi-out time in minutes for a representative time period.	ASQP Fields (Taxi-Out Time) Field 25 Taxi-Out Time

2.4 System Flexibility

As described in the ATS Performance Plan, national airspace users desire the capability to optimize their operations based on their own objectives and constraints, which vary flight-by-flight and user-by-user. In terms of climbs and descents, ideal operations would permit departures to climb quickly to their cruise altitude, where they would remain as long as possible, then descend in the least possible time to the destination airport. When departure sectors are busy, departures are sometimes obligated to level off while still in TRACON airspace, until they are below a particular departure airport. This causes them to avoid another congested sector, but it does so in a way that is expensive to the user. These metrics measure the flexibility of the system to allow the users to fly their preferred climb and descent profiles. In this example, long climb or descent times may indicate that the aircraft are restricted in altitude for specific sectors associated with congested airspace. However, note that in other circumstances, an increase in climb or descent times may also indicate increased system flexibility. For example, for aircraft departing an airport with long delays associated with the aircraft's proposed departure route, the aircraft may choose to take a non-optimal route to depart sooner.

Table 2-5. Steps 1 and 2 System Flexibility Metrics

Indicator	Metric	Definition	Example Data Sources or Analytical Tools
System Flexibility	11. Average Climb Times	Average time from departure to top of climb in minutes for a representative time period.	<u>ETMS Message Types (Departure, Top of Climb Times)</u> DZ (Departure) FZ Projected Departure Time TZ (Track Update) <u>ARTS/SAR (Top of Climb Times)</u> Track Position Reports <u>SDAT (Departure, Top of Climb Time)</u> View climb profiles in two-dimensions (2-D) side view (elevation). <u>ARCVIEW (Departure, Top of Climb Times)</u> View climb profiles to analyze number and location of inflection points
	12. Average Descent Times	Average time from top of descent to arrival in minutes for a representative time period.	<u>ETMS Message Types (Top of Descent, Arrival Times)</u> TZ (Track Update) AZ (Arrival) <u>ARTS/SAR (Top of Descent)</u> Track Position Reports <u>SDAT (Top of Descent, Arrival Times)</u> View descent profiles in two-dimensions (2-D) side view (elevation). <u>ARCVIEW (Top of Descent, Arrival Times)</u> View descent profiles to analyze number and location of inflection points

2.5 System Predictability

These metrics indicate whether there is large time variability associated with en route and departure times.

2.5.1 En Route Time Variability

This metric indicates whether there is a large variability of en route times associated with a particular airport arrival and destination pair. A significant increase in flying times between airports during certain periods of the day would indicate a congestion problem.

Table 2-6. Steps 1 and 2 En Route Variability Metric

Indicator	Metric	Definition	Example Data Sources or Analytical Tools
System Predict-ability	13. En Route Time Variability	Variability of En Route times for routes with 5 or more flights to an airport for a representative time period.	<u>ASQP Fields (En RouteTime)</u> Field 3 Departure Airport Field 4 Actual Airport Field 5 Year of Data Date Field 6 Month of Data Date Field 7 Day of Month for Flight Field 18 Elapsed Flight Time <u>ARCVIEW (En Route Time)</u> Shows geospatial variability in tracks and computes statistics <u>SDAT (En Route Time)</u> File: *.tsum_rpt: Field name: TKTotmins (Track total minutes) per flight File: *.tsum_rpt Field name: FPTotmins (Flight Plan total minutes) per flight <u>ADL Flight Data Fields (En Route Time)</u> 11. AETD Actual Time of Departure 12. AETA Actual Time of Arrival

2.5.2 Arrival Time Variability

This metric indicates whether there is a large variability of arrival times associated with a particular airport.

Table 2-7. Steps 1 and 2 Arrival Time Variability Metric

Indicator	Metric	Definition	Example Data Sources or Analytical Tools
System Predict-ability	14. Arrival Time Variability	Variability of arrival times for routes with 5 or more flights to an airport for a representative time period.	ASQP Fields (Arrival Time) Field 3 Departure Airport Field 4 Arrival Airport Field 5 Year of Data Date Field 6 Month of Data Date Field 7 Day of Month for Flight Field 13 CRS Arrival Time ADL Flight Data Field (Arrival Time) 12. AETA Actual Time of Arrival

2.5.3 Departure Time Variability

This metric indicates whether there is a large variability of departure times associated with a particular airport pair.

Table 2-8. Steps 4, 1 and 2 Departure Variability Metric

Indicator	Metric	Definition	Example Data Sources or Analytical Tools
System Predict-ability	15. Departure Time Variability	Variability of departure times for routes with 5 or more flights to an airport for a representative time period.	ASQP Fields (Departure Time) Field 3 Departure Airport Field 4 Arrival Airport Field 5 Year of Data Date Field 6 Month of Data Date Field 7 Day of Month for Flight Field 10 CRS Departure Time ADL Flight Data Field (Departure Time) 11. AETA Actual Time of Arrival

2.6 System Productivity

System productivity is measured by the number of operations within a sector for intervals within a representative time period. For analysis of minor flow changes within a sector such as increased traffic, the sector throughput maybe compared against the Monitor Alert Threshold to determine the extent to which the threshold is exceeded during the calculated time periods.

Table 2-9. Steps 1 and 2 System Productivity Metric

Indicator	Metric	Definition	Example Data Sources or Analytical Tools
System Produc-tivity	16. Sector Throughput	Peak number of aircraft per sector for intervals within a representative time period.	<u>ETMS (Aircraft Per Sector)</u> TZ (Track Update) ARTS/SAR (Aircraft per Sector) Track Position Reports

2.7 System Capacity

These metrics calculate the ratio of arrival and departure operations to total capacity.

Table 2-10. Steps 1 and 2 System Capacity Metrics

Indicator	Metric	Definition	Example Data Sources or Analytical Tools
System Capacity	17. Airport arrival Utilization	Ratio of arrival operations to arrival capacity for a representative period per applicable airport(s).	<u>ATCSCC or Facility Log Fields (Airport Capacity)</u> AAR <u>ETMS Message Types (Arrival Operations)</u> AZ (Arrival) TZ (Track Update) <u>ARTS/SAR (Arrival Operations)</u> First and last applicable Track Position Reports <u>SDAT (Arrival Operations)</u> Configure Traffic to display arrivals for selected airport(s) File *.tsm_rpt will contain list of arrivals <u>ADL Flight Data Fields (Arrival Operations)</u> 12. AETA Actual Time of Arrival
	18. Airport Departure Utilization	Ratio of departure operations to departure capacity for a representative period per applicable airport(s).	ATCSCC or Facility Log fields (Airport Capacity) ADR <u>ETMS Message Types (Departure Operations)</u> DZ (Departure) TZ (Track Update) <u>ARTS/SAR (Departure Operations)</u> First and last applicable Track Position Reports <u>SDAT (Departure Operations)</u> Configure Traffic to display departures from selected airport(s) File *.tsum_rpt will contain list of departures ADL Flight Data Fields (Departure Operations) 11. AETD Actual Time of Departure

2.8 Environmental Impact

This metric provides an indication as to the projected change in noise level for early noise evaluation of an airspace change. Note that this metric may indicate an increase or decrease of noise levels within the study area.

Table 2-11. Steps 1 and 2 Environmental Impact Metric

Indicator	Metric	Definition	Example Data Sources or Analytical Tools
Environmental Impact	19. Day-Night Average Sound Level	Difference between baseline and proposed change overall DNL. It is recommended that the appropriate policy office should be consulted if there is an increase of 5 dB in the overall DNL for a residential community examined. It is recommended that the results be coordinated with the appropriate Air Traffic Division Environmental Specialist.	ATNS output report file (as viewed in the Current Assessment Finished pop-up window)

Step 4 (Conduct Airspace Study) Metrics

3.1 Introduction

Figure 3-1 shows a roadmap to the Step 4 metrics to be used when conducting an airspace study to evaluate an airspace change as identified by the FAA Airspace Management Handbook. This list does not preclude the use of additional metrics for assessing the extent to which a problem exists. The indicators identify the aspect of the NAS performance of concern and is used to help the analyst to select a metric.

When conducting an airspace assessment, the analyst will choose among the listed metrics based on the nature of the proposed airspace change as identified by the indicator. For example if an analyst is trying to quantify alternatives associated with airspace change that may reduce arrival delays, the metric grouped under the indicator *System Delay/Efficiency* (i.e., metric 4) should be used. The use of additional metrics grouped under other indicators (e.g., *System Flexibility*) is left to the analyst's discretion.

Once metrics are selected, an analyst may have to specify a representative time period. For example, an Arrival Delay metric could be used to identify whether an airspace change impacts delays hourly, daily or monthly arrival times. Metric details are provided in Section 3. These metrics are measurable via simulation or modeling.

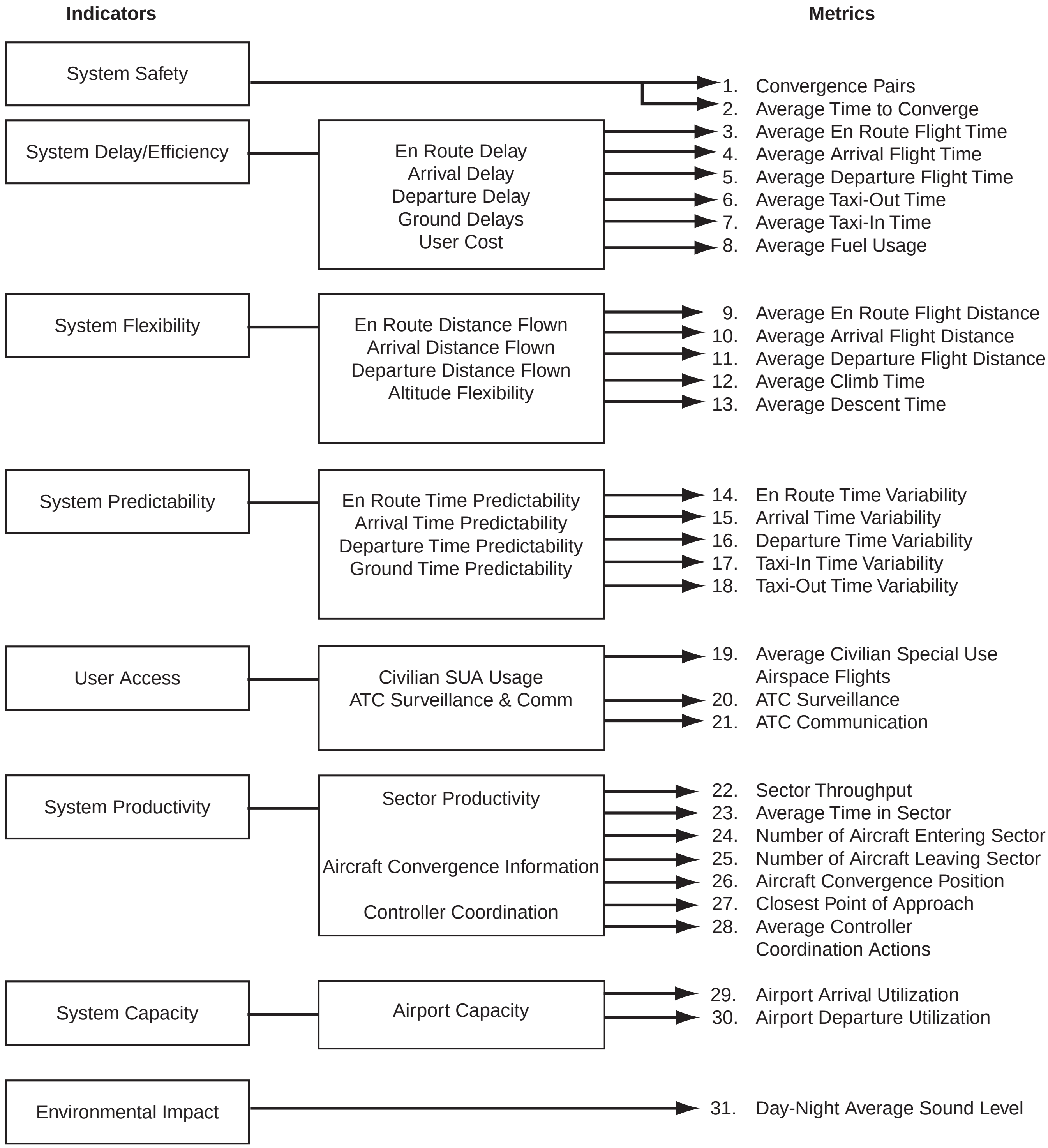

Figure 3-1. Step 4 Metrics

3.2 System Safety

These metrics indicate whether the number of potential conflicts (called convergence pairs) increase or decrease with the proposed airspace change and examine the time to conflict. These metrics can be used to indicate the current level of safety associated with a specific airspace, and may indicate a sector that should be evaluated for possible redesign to maintain a safe environment.

These metrics should be determined for both the baseline and for the airspace change.

Table 3-1. Step 4 System Safety Metrics

Indicator	Metric	Definition	Example Analytical Tools
System Safety	1. Convergence pairs	Number of convergence pairs per ARTCC or sectors of applicable airspace for a representative time period.	TAAM (Convergence Pairs) File: *.rep Field Name: sect_conflict RAMS (Convergence Pairs) File: conflictabl.out.1 Field: FLIGHTPLANKEY SDAT (Convergence Pairs) File: *.con_rpt At the end of this file, there is a list of all sectors and number of conflict points for each sector File: *.con_ss Field name: Conflict Point Ids
	2. Average Time to Converge	The average time from an aircraft crossing a sector boundary to the time that a potential loss of separation is detected with another aircraft.	TAAM (Time to Converge) File *.REP Field name: sector count conflicts File: *.REP Field name: sector_movement RAMS (Time to Converge) File: conflicttab.out.1 Field name: Closest Point of Approach Time File:FLIGHTHISTORY Field Name: Event Time Field Name: #SP SDAT (Time to Converge) File:*.secload_rpt Field name: Entry/Exit Times and Altitudes Field name: Sector Entry File; *.con_rpt Field name: Sector, Aircraft ID, Time of Conflict

3.3 System Delay/Efficiency

Delay is categorized here as arrival, departure or ground delays associated with a particular airport. Efficiency is categorized as fuel efficiency in terms of average fuel usage. Note that reduction in system delay does not necessarily imply a reduction in fuel usage or flight distances. Depending on the airspace design and airline practices, an airspace change that reduces system delay may increase fuel usage and/ or flight distances.

3.3.1 En Route Delays

For airspace changes that are anticipated to impact the en route time, these metrics determine the en route flight time from wheels-off to wheels-on for an airport departure and arrival pair. These metrics should be determined for both the baseline airspace, and for the proposed airspace change. The difference in times between the baseline and airspace change will indicate whether an airspace change is increasing or decreasing delays.

Table 3-2. Step 4 En Route Delays Metric

Indicator	Metric	Definition	Example Analytical Tools
System Delay	3. Average En Route Flight Time	Average take-off to landing times for a representative time period.	TAAM (En Route Time) File: *.hst Field Name: TAKING _OFF->LANDING RAMS (En Route Time) File: flight.out.1 Field name: #RWRBLOCK-ARR Field name: #RWRBLOCK-DEP File: flight.out.1 Field name: Flight Phase at this Point Field name: Event Time SDAT (En Route Time) File: *.tsum_rpt Field name: TKTotmins (track total minutes) File: *.tsum_rpt Field name: TKTotmins (flight Plan total minutes) SIMMOD (En Route Time) File: *.DTW Report: Air and Ground Travel and Delay ARCVIEW (En Route Time) Display and analyze variability in ETMS v5.6 flight times and trajectory shapes

3.3.2 Arrival Delays

For airspace changes that are anticipated to impact arrival delays, these metrics determine the arrival times and delay from an airspace boundary all the way to the runway. These metrics should be determined for both the baseline airspace, and for the proposed airspace change.

Table 3-3. Step 4 Arrival Delays Metric

Indicator	Metric	Definition	Example Analytical Tools
System Delay	4. Average Arrival Flight Time	Average time from where an aircraft crosses an airspace boundary that is common to both the baseline and airspace change to landing for a representative time period.	<u>TAAM (Arrival Flight Time)</u> File: *.hst Field name: SECTOR_CHNG->LANDING <u>RAMS (Arrival Flight Time)</u> File: flight.out.1 Field name: Flight Phase at this Point Field name: Event time <u>SIMMOD (Arrival Flight Time)</u> File: SIMU26 Field name: NM (Aircraft travels at specified speed between 2 nodes in the airspace) Field name: RL (Arrival aircraft begins landing roll)

3.3.3 Departure Delays

These metrics determine the departure times from the runway to the associated airspace boundary. These metrics should be determined for both the baseline airspace, and for the proposed airspace change.

Table 3-4. Step 4 Departure Delays Metric

Indicator	Metric	Definition	Example Analytical Tools
System Delay	5. Average Departure Flight Time	Average time from an aircraft's take-off to crossing an airspace boundary that is common to both the baseline and airspace change for a representative time period.	<u>TAAM (Departure Flight Time)</u> File: *.hst Field name: TAKING_OFF->SECTOR_CHNG <u>RAMS (Departure Flight Time)</u> File: flight.out.1 Field name: Flight Phase at this Point Field name: Event Time <u>SIMMOD (Departure Flight Time)</u> File: SIMU26 Field name: RT (Departure aircraft begins takeoff roll) Field Name: NM (Aircraft travels at specified speed between 2 nodes in the airspace)

3.3.4 Ground Delays

For airspace changes that are anticipated to impact ground delays, these metrics determine both taxi-in and taxi-out times. These metrics should be determined for both the baseline airspace, and for the proposed airspace change.

Table 3-5. Step 4 Ground Delay Metrics

Indicator	Metric	Definition	Example Analytical Tools
System Delay	6. Average Taxi-Out Time	Average time from gate to take-off for a representative time period.	<u>TAAM File and Field Names (Taxi-Out Time)</u> File: *.hst Field name: AT_GATE->TAKING_OFF <u>RAMS (Taxi-Out Time)</u> File: flight.out.1 Field name: Flight Phase at this Point Field name: Event Time <u>SIMMOD (Taxi-Out Time)</u> File: *.DTW Report: Runway Air and Ground Travel and Delay <u>ARCVIEW (Taxi-Out Time)</u> Use for airport design analysis if a digitized (or scanned AUTOCAD drawing) airport map is available.
	7. Average Taxi-In Time	Average time from landing to gate for a representative time period.	<u>TAAM File and Field Name (Taxi-In Time)</u> File: *.hst Field name: LANDING->AT_GATE <u>RAMS (Taxi-In Time)</u> File: flight.out.1 Field name: Flight Phase at this Point Field name: Event Time <u>SIMMOD (Taxi-In time)</u> Use for airport design analysis if a digitized (or scanned AUTOCAD drawing) airport map is available

3.3.5 User Cost

This metric measures the average fuel burn associated specific aircraft flight through an airspace. This metric should be determined for both the baseline and for the proposed airspace change.

Table 3-6. Step 4 Fuel Usage Metric

Indicator	Metric	Definition	Example Analytical Tools
User Cost	8. Average Fuel Usage	Average fuel usage for flights during a representative time period.	TAAM (Fuel Burn) File: *.rep Field name: fuel_burn_this_hr, fuel_burn_accum RAMS (Fuel Burn) File: flight.out.1 Field name:Fuel burn for this flight

3.4 System Flexibility

As described in the ATS Performance Plan, national airspace users desire the capability to optimize their operations based on their own objectives and constraints, which vary flight-by-flight and user-by-user. Users may experience inflexibility during the flight planning process based on published ATC preferred routes. They may also desire to vary the flight objectives based on an early or late departure and requests for altitude changes for passenger comfort. Flexibility may be also measured in terms of a change in an airline's ability to keep its schedule. For example, the users may accept a route or altitude other than their preference to get an en route flying time closer to their preference or the flight's scheduled time. Note that depending on the circumstances, a reduction in flight distance may not necessarily indicate increased flexibility. For example, an airline may choose a longer flight distance to meet the planned schedule. This choice may be based on anticipated weather along the planned route or other operational factors.

3.4.1 Aircraft Flying Distances

An airspace change may reduce or increase en route, arrival or departure flying distances. Depending on the airspace assessment, one or more of these metrics may be applicable to the airspace problem.

Table 3-7. Step 4 Aircraft Flying Distances Metrics

Indicator	**Metric**	**Definition**	**Example Analytical Tools**
System Flexibility	9. Average En Route Flight Distance	Average number of en route flight miles between two airports for a representative time period.	<u>TAAM (En Route Flight Distance)</u> File: *.hst Field name: TAKING_OFF->LANDING <u>RAMS (En Route Flight Distance)</u> File: flight.out.1 Field name: latitude position Field name: longitude position Field name: Actual Flight Level; Field name: Flight Phase at this Point File: atcdetailcost.out.1 Field name: Nautical mile distance flown by the flight in the sector SDAT (En Route Flight Distance) File: *.tsum_rpt: Field name: TKTotDist (Track total distance) File: *.tsum_rpt: Field name: FPTotDist (Flight Plan total distance)
	10. Average Arrival Flight Distance	Average distance from where an aircraft crosses an airspace boundary that is common to both the baseline and airspace change to ariport arrival for a representative time period	TAAM (Arrival Flight Distance) File: *.hst Field name: SECTOR_CHNG->LANDING RAMS (Arrival Flight Distance) File: flight.out.1 Field name: latitude position Field name: longitude position Field name: Actual Flight :eve; Field name: Flight Phase at this Point File: atcdetailcost.out.1 Field name: Nautical mile distance flown by the flight in the sector ARCVIEW (Arrival Flight Distance) If a marked crossing point on an aeronautics chart is scanned into ARCVIEW, then the ETMS v5.6 tracks can be analyzed.

Table 3-7. Step 4 Aircraft Flying Distances Metrics (Concluded)

Indicator	Metric	Definition	Example Analytical Tools
System Flexibility	11. Average Departure Flight Distance	Average distance from an aircraft's departure time to crosssing an airspace boundary that is common to both the baseline and airspace change for a representative time period.	TAAM (Departure Flight Distance) File *.hst Field name: TAKING_OFF->SECTOR_CHNG RAMS (Departure Flight Distance) File: flight.out.1 Field name: latitude position Field name: longitude position Field name: Actual Flight Level Field name: Flight Phase at this Point File: atcdetailcost.out.1 Field name: Nautical mile distance flown by the flight in the sector ARCVIEW (Departure Flight Distance) Can be used for obstruction evaluation. If a marked crossing point on an aeronautical chart is scanned into ARCVIEW, then the ETMS v5.6 tracks can be analyzed.

3.4.2 Change in Descent/Climb Times

If there are long descent or climb times associated with an airspace problem, these metrics will evaluate whether an airspace change improves these times and should be determined for both the baseline and proposed airspace change.

Table 3-8. Step 4 Change in Descent/Climb Time Metrics

Indicator	Metric	Definition	Example Analytical Tools
System Flexibility	12. Average Climb Times	Average time from take-off to top of climb for a representative time period.	TAAM (Climb Time) File: *.hst Field name: TAKING_OFF->START_OF_CRUISE RAMS (Climb Time) File: flight.out.1 Field name: latitude position Field name: longitude position Field name: Actual Flight Level Field name: Flight Phase at this Point SIMMOD (Climb Time) File: SIMU26 Field: TA (Departure aircraft transitions from ground to airspace) ARCVIEW (Climb Time) Shows trajectory profiles and inflection points
	13. Average Descent Times	Average time from top of descent to landing for a representative time period.	TAAM (Descent Time) File: *.hst Field name: END_OF_CRUISE->LANDING RAMS (Descent time) File: flight.out.1 Field name: latitude position Field name: longitude position Field name: Actual Flight Level Field name: Flight Phase at this Point SIMMOD (Descent Time) File: SIMU26 Field: NM (Aircraft travels at specified speed between 2 nodes in the airspace) Field: RL (Aircraft begins landing roll) ARCVIEW (Descent Time) Shows trajectory profiles and inflection points

3.5 System Predictability

These metrics will indicate whether there is large time variability associated with a specific phase of flight (en route time, arrival, departure time, and ground taxi time).

3.5.1 En Route Time Variability

This single metric indicates whether there is a large variability of en route times associated with a particular airport arrival and destination pair. This metric should be determined for both the baseline airspace, and for the proposed airspace change.

Table 3-9. Step 4 En Route Time Variability Metric

Indicator	Metric	Definition	Example Analytical Tools
System Predict-ability	14. En Route Time Variability	Variability of time from departure to arrival for a representative time period.	<u>TAAM (En Route Time)</u> File: *.hst Field name: TAKING_OFF->LANDING <u>RAMS (En Route Time)</u> File: flight.out.1 Field name: Flight Phase at this Point Field name: Event Time <u>SDAT (En Route Time)</u> File: *.tsum_rpt: Field name: TKTotmins (Track total minutes) File: *.tsum_rpt Field name: FPTotmins (Flight Plan total minutes) <u>SIMMOD (En Route Time)</u> File: *.DTW Report: Airport Air and Ground Travel and Delay <u>ARCVIEW (En Route Time)</u> Display and analyze variability in ETMS v5.6 flight times and trajectory shapes

3.5.2 Arrival Time Variability

This single metric indicates whether there is a large variability of arrival times associated with a particular airport pair. This metric should be determined for both the baseline and for the proposed airspace change.

Table 3-10. Step 4 Arrival Time Variability Metric

Indicator	Metric	Definition	Example Analytical Tools
System Predict-ability	15. Arrival Time Variability	Variability of time from where an aircraft crosses an airspace boundary that is common to both the baseline and airspace change to arrival for a representative time period.	<u>TAAM (Arrival Time)</u> File: *.hst Field name: SECTOR_CHNG->LANDING <u>RAMS (Arrival Time)</u> File: flight.out.1 Field name: latitude position Field name: longitude position Field name: Actual Flight Level Field name: Flight Phase at this Point Field name: Event Time <u>SDAT (Arrival Time)</u> File: *.impact_rpt Field name: Delta Time (Total difference in time before and after change) <u>SIMMOD (Arrival time)</u> File Name: SIMU26 Field Name: NM (Aircraft travels at specified speed between 2 nodes in the airspace) <u>ARCVIEW (Arrival Time)</u> Can also be used by marking a crossings point on an aeronautical chart scanned into ARCVIEW and analyze ETMS v5.6 tracks from there to destination airport.

3.5.3 Departure Time Variability

This single metric indicates whether there is a large variability of departure times associated with a particular airport pair. This metric should be determined for both the baseline and for the proposed airspace change.

Table 3-11. Step 4 Departure Time Variability Metric

Indicator	Metric	Definition	Example Analytical Tools
System Predict-ability	16. Departure Time Variability	Variability of the time from an aircraft's departure to crossing an airspace boundary that is common to both the baseline and airspace change for a representative time period.	<u>TAAM (Departure Time)</u> Calculate time between each lat/long between fields TAKING_OFF->SECTOR_CHNG in File: *.hst <u>RAMS (Departure Time)</u> File: flight.out.1 Field name: latitude position Field name: longitude position Field name: Actual Flight Level Field name: Flight Phase at this Point Field name: Event Time <u>SDAT (Departure Time)</u> File: *.impact_rpt Field name: Delta Dist (Total difference in distance before and after change) <u>SIMMOD (Departure Time)</u> File: SIMU26 Field: RT (Departure Aircraft begins take-off roll) Field: TA (Departure aircraft transitions from ground to airspace) <u>ARCVIEW (Departure Time)</u> Can be used by marking a crossing point on an aeronautical chart scanned into ARCVIEW and analyze ETMS v5.6 tracks from airport to airspace change.

3.5.4 Ground Taxi Time Variability

This single metric indicates whether there is a large variability of ground taxi times associated with a particular airport. Depending on the airspace assessment, taxi-in and/or taxi-out times may be examined. These metrics should be determined for both the baseline and for the proposed airspace change.

Table 3-12. Step 4 Ground Taxi Time Variability Metrics

Indicator	Metric	Definition	Example Data Sources or Analytical Tools
System Predict-ability	17. Taxi-In Time Variability	Variability of landing to gate times for a representative time period.	TAAM (Taxi-Out Time) File: *.hst Field name: LANDING->AT_GATE RAMS (Taxi-In Time) File: flight.out.1 Field name: Flight Phase at this Time Field name: Event Tme SIMMOD (Taxi-In Time) File: SIMU26 Field: RL (Arrival aircraft begins landing roll) Field: AD (Arrival unloading gate) ARCVIEW (Taxi-In Time) Could scan airport layout into ARCVIEW but surface tracks would need to be available.
	18. Taxi-Out Time Variability	Variability of gate to take-off times for a representative time period.	TAAM (Taxi-In Time) File: *.hst Field name: AT_GATE->TAKING_OFF RAMS (Taxi-In Time) File: flight.out.1 Field name: Flight Phase at this Point Field name: Event Time SIMMOD (Taxi-Out Time) File: SIMU26 Field: DB (Departure begins boarding at gate) Field: RT (Departure aircraft begins takeoff roll) ARCVIEW (Taxi-Out Time) Could scan airport layout into ARCVIEW but surface tracks would need to be available.

3.6 User Access

These metrics are used to indicate whether there is increased civilian use of special use airspace, adequate communication and surveillance coverage, and change in the arrival or departure capacity of an airport. These metrics should be determined for both the baseline and for the proposed airspace change.

3.6.1 Civilian Special Use Airspace Usage

This metric indicates whether the civilian use of special use airspace is increasing or decreasing by measuring the number of flights flying through Special Use Airspace (SUA). This metric is applicable to investigate an airspace design that does not change SUA boundaries, but does change the flow of traffic through an SUA (e.g. modifying schedule of SUA status). This metric should be determined for both the baseline and for the proposed airspace change.

Table 3-13. Step 4 Civilian Special Use Airspace Usage Metric

Indicator	Metric	Definition	Example Analytical Tools
User Access	19. Average Civilian Special Use Airspace Flights	Average number of flights using Special Use Airspace for a representative time period.	TAAM (Flights within a sector) File: *.rep Field name: sect_movement RAMS (Flights within a sector) File: FLIGHTHISTORY Field name: Event Time Field name: #SP SDAT (Flights within a sector) Visually look at track before and after airspace change. SIMMOD (Flights within a sector) File: *.DTW Report: Airport Air and Ground Travel and Delay ARCVIEW (Flights within a sector) Display and analyze ETMS v5.6 flight tracks.

3.6.2 Communication and Surveillance Coverage

These metrics indicate whether there is adequate communications and surveillance coverage associated with a proposed airspace change. These metrics should be determined for both the baseline and for the proposed airspace change.

Table 3-14. Step 4 Communication and Surveillance Coverage Metrics

Indicator	Metric	Definition	Example Analytical Tools
User Access	20. Air Traffic Control Surveillance	Air Traffic Control surveillance coverage for airspace change for a representative time period.	RACOMS Basic, Incremental, Overlapping Coverage and Coverage Count Maps available.
	21. Air Traffic Control Communication	Air Traffic Control communication coverage for airspace change for a representative time period.	RACOMS Basic, Incremental, Overlapping Coverage and Coverage Count Maps available

3.7 System Productivity

System productivity is measured by a number of factors associated with sector productivity, convergence information and controller coordination activities as shown in the metric tables below. To determine a single result from these metrics, the metrics may be weighted and combined. Because these weights will be driven by the underlying airspace environment, this document does not assign values for these weights.

3.7.1 Sector Productivity

These metrics indicate the level of activity within a sector. This metric should be determined for both the baseline and for the proposed airspace change. For analysis of minor flow changes within a sector such as increased traffic, the sector throughput can be compared against the Monitor Alert Threshold to determine if the threshold is exceeded during the calculated time periods.

Table 3-15. Step 4 Sector Productivity Metrics

Indicator	Metric	Definition	Example Data Sources or Analytical Tools
System Productivity	22. Sector Throughput	Peak number of aircraft per sector for intervals within a representative time period.	TAAM (Sector Throughput) File: *.hst Field name: SECTOR_CHNG RAMS (Sector Throughput) File: FLIGHTHISTORY Field name: Event Time Field name: #SP File: statcontroller.out.1 Field name: Maximum number of flights SDAT (Sector Throughput) File: *.trafload_rpt Field name: Flights (total) Field name: Throughput (Flights per Hour) File: *.secload_rpt: Field name: Total Flights Field name: Total Sector Crossings SIMMOD (Sector Throughput) File: SIMU26 Field: NM (Aircraft travels at specified speed between two nodes in the airspace).

Table 3-15. Step 4 Sector Productivity Metrics (Concluded)

Indicator	Metric	Definition	Example Analytical Tools
System Produc-tivity	23. Average Time in Sector	Average time for aircraft transitioning the sector.	<u>TAAM (Time in Sector)</u> File: *.REP Field name: Sector_movement <u>RAMS (Time in Sector)</u> File: FLIGHTHISTORY Field name: Event Time Field name: #SP <u>SDAT (Time in Sector)</u> File: *.secload_rpt Field name: Entry/Exit Times and Altitudes Field name: Duration File: *.secload_ss Field name: Duration <u>SIMMOD (Time in Sector)</u> File: SIMU26 Field: NM (Aircraft travels at specified speed between two nodes in the airspace).
	24. Average Number of Aircraft Entering a Sector	Average number of aircraft entering a sector within a representative time period.	<u>TAAM (Number of Aircraft in Sector)</u> File: *.REP Field name: sector_movement <u>RAMS (Number of Aircraft in Sector)</u> File: FLIGHTHISTORY Field name: Event Time Field name: #SP <u>SDAT (Number of Aircraft in Sector)</u> File: *.secload_rpt Field name: Entry/Exit Times and Altitudes Field name: Sector Entry File: *.secload_ss Field name: Entry Time
	25. Average Number of Aircraft Leaving a Sector	Average number of aircraft departing a sector within a representative time period.	<u>TAAM (Number of Aircraft Departing Sector)</u> File: *.REP Field name: sector_movement <u>RAMS (Number of Aircraft Departing Sector)</u> File: FLIGHTHISTORY Field name: Event Time Field name: #SP <u>SDAT (Number of Aircraft Departing Sector)</u> File: *.secload_rpt Field name: Entry/Exit Times and Altitudes Field name: Sector Exit File: *.secload_ss Field name: Exit Time

3.7.2 Detailed Aircraft Conflict Information

These metrics examine the position, movement and distance between two aircraft that are expected to converge.

Table 3-16. Step 4 Aircraft Conflict Information Metrics

Indicator	Metric	Definition	Example Analytical Tools
System Productivity	26. Aircraft Convergence Position	Indicates position and movement of the two aircraft at time of possible loss of separation for a representative time period. (For example, whether one aircraft is overtaking, crossing or opposite another aircraft, and whether one or both aircraft are climbing or descending).	TAAM (Aircraft Convergence Position) File: *.REP Fields: sect_conflict RAMS (Aircraft Convergence Position) File: conflicttab.out.1 Field name: Start Status of Conflict
	27. Closest Point of Approach	Indicates the nautical mile distance between the aircraft at their closest point of loss of separation for a representative time period.	TAAM (Closest Point of Approach) File: *.REP Field name: Distance of Closest Approach RAMS (Closest Point of Approach) File: conflicttab.out.1 Field name: Closest Point of Approach, Distance

3.7.3 Controller Coordination

This metric determines the number of controller coordination activities that occur within a specific sector of interest.

Table 3-17. Step 4 Controller Coordination Metric

Indicator	Metric	Definition	Example Analytical Tools
System Productivity	28. Average Controller Coordination Actions	Indicates the number of controller coordination actions per sector for a representative time period. Coordination actions can include issuing clearances, transferring aircraft to tower, silent transfers, inter-center coordination and intracenter coordination	TAAM (Controller Actions) File: *.REP Field name: sect_coord_action RAMS (Controller Actions) File: CONTROLLERTASK Field name: TRAFFIC_FlightCallSign Field name: AIRSPACE_Sector Field name: ATCACTIVITY Field name: Time Duration

3.8 System Capacity

These metrics calculate the ratio of arrival and departure operations to total capacity. These metrics should be determined for both the baseline and for the proposed airspace change.

ATCSCC or facility logs typically include the airport arrival rate (AAR) and airport departure rate (ADR) information. These AARs and ADRs represent the maximum hourly arrival and departure rates for a specific airport for a specific date and time. These rates are reported from the facility and take into account the airport's configuration and weather conditions.

Table 3-18. Step 4 Airport Capacity Metrics

Indicator	Metric	Definition	Example Analytical Tools
System Capacity	29. Airport Arrival Utilization	Ratio of arrival operations to arrival capacity for a representative time period per selected airport(s).	ATCSCC or Facility Log Fields (Airport Capacity) AAR TAAM (Arrival Operations) File: *.rep Field name: apt_movement RAMS (Arrival Operations) File: statrunway.out.1 Field name: Airport Field name: Runway File: Number of Arrivals SDAT (Arrival Operations) File: *.sec_rpt Examine Arrival Points and Departure Points and manually count SIMMOD (Arrival Operations) GTE_ITER_BKT_HC_CNT report

Table 3-18. Step 4 Airport Capacity Metrics (Concluded)

Indicator	Metric	Definition	Example Data Sources or Analytical Tools
System Capacity	30. Airport Departure Utilization	Ratio of departure operations to departure capacity for a representative time period per selected airport(s).	ATCSCC or Facility Log Fields (Airport Capacity) ADR RAMS (Arrival Operations) File: statrunway.out.1 Field name: Airport Field name: Runway File: Number of departures TAAM (Departure Operations) File: *.rep Field name: apt_movement SDAT (Departure Operations) File: *.sec_rpt Examine Arrival Points and Departure Points and manually count SIMMOD (Departure Operations) GTE_ITER_BKT_HC_CNT report

3.9 Environmental Impacts

While there are a number of environmental impact categories, only the noise impact is considered at this time.[1] Noise impact is measured by the levels of noise associated with the airspace change as documented in FAA Order 1050.1D, Policies and procedures for Considering Environmental Impacts and FAA Order 5050.4A, Airport Environmental Handbook. This metric should be determined for both the baseline and for the proposed airspace change.

Table 3-19. Step 4 Environmental Impact Metric

Indicator	Metric	Definition	Example Analytical Tools
Environmental Impact	31. Day-Night Average Sound Level	The day-night average sound level contour map (INM) or difference in DNL for population centers (NIRS).	<u>INM</u> DNL <u>NIRS</u> DNL

[1] There are 23 environmental impact categories. While noise is a primary environmental concern for air traffic actions, it is not the only impact category of concern. INM and NIRS, so far, only measure noise impacts, and not other environmental impacts. Eventually, NIRs should support assessments of environmental justice, historical preservation, public lands, and other impact categories.

Step 7 (Evaluate Implementation) Metrics

4.1 Introduction

Figure 4-1 shows a roadmap to the Step 7 metrics to be used for evaluating an implemented airspace change as identified by the FAA Airspace Management Handbook. This list does not preclude the use of additional metrics for assessing the extent to which a problem exists. The indicators identify the aspect of the NAS performance of concern and is used to help the analyst to select a metric. Metrics are provided to evaluate the impact of an airspace change based on the metrics selected in Step 1. These operationally related metrics should be measurable by information available to the field facility. While example data sources are provided for the metrics, depending on the data resources of the facility, other sources may be equally applicable and chosen.

When evaluating an implemented airspace change, the analyst will choose the listed metrics based on the metrics selected in Steps 1 and 2. A comparison between the values of the metrics given in Steps 1 and 2 and Step 7 will provide an indication as to whether the objectives of the airspace change occurred. For example if an airspace change was expected in decrease arrival delays, then the arrival delay should be evaluated and compared to the baseline value given in Steps 1 and 2.

Once metrics are selected, an analyst may have to specify a representative time period. The time period should ensure that the expected outcome is achieved based on the metrics selected in Steps 1 and 2.

4.2 Metric Descriptions

The Step 7 metrics as shown in Figure 4-1 are based on the same definitions as given in Steps 1 and 2. Step 7 metric definitions are provided in Sections 2.1 through 2.7. Note that environmental impact metrics, while specified in Steps 1 and 2, are not provided for Step 7. As part of any monitoring and evaluation of an implemented airspace change, additional metrics associated with environmental impact may be required.

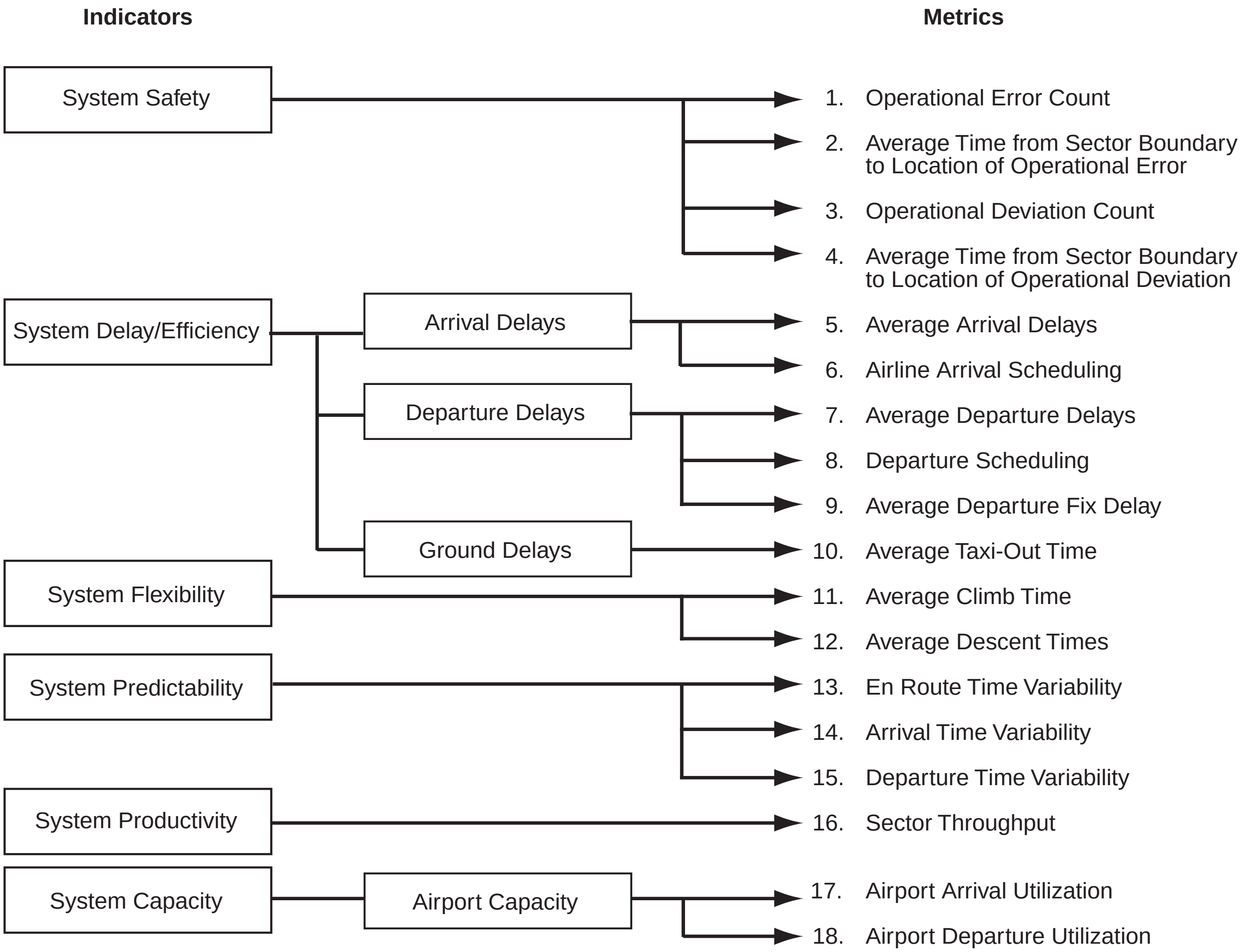

Figure 4-1. Step 7 Metrics

Summary

This document identifies an initial core set of metrics for evaluating the benefits of airspace redesign according to the steps in the FAA Airspace Management Handbook. Metrics are proposed for Steps 1 (Characterize Problem), 2 (Perform Initial Evaluation), 4 (Conduct Airspace Study) and 7 (Evaluate Implementation.) A metrics roadmap is provided for each applicable step to show the indicators and associated metrics. The metrics are selectable based on the indicators addressed by the airspace study. However, this document does not preclude the use of additional metrics as needed.

It is expected that this document will be revised depending on the users needs, and depending on new metrics research. For example, currently this document contains metrics associated with system productivity. Metrics related to system productivity are documented in a number of research papers and a limited survey of these papers are listed in the Bibliography of this document. In addition, there are some airspace tools that calculate system productivity metrics (such as TAAM and RAMS). While this handbook has proposed system productivity metrics, it is worth noting that there is still a general lack of consensus on these metrics within the research community and research activities continue. As additional insight is gained in this area, these metrics should be re-evaluated and updated.

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Glossary

AAR	Airport Arrival Rate
ADL	Airport Demand List
ADR	Airport Departure Rate
ARTCC	Air Route Traffic Control Center
ARTS	Automated Radar Terminal System
ASQP	Airline Service Quality Performance
ATC	Air Traffic Control
ATCSCC	Air Traffic Control System Command Center
ATCT	Air Traffic Control Tower
ATNS	Air Traffic Noise Screening Model
ATS	Air Traffic Services
CAASD	Center for Advanced Aviation System Development
CDM	Collaborative Decision Making
CFR	Code of Federal Regulations
ETA	Estimated Time of Arrival
ETD	Estimated Time of Departure
ETMS	Enhanced Traffic Management System
FAA	Federal Aviation Administration
FSM	Flight Schedule Monitor
IFR	Instrument Flight Rules
INM	Integrated Noise Model
LOA	Letter of Agreement
NAS	National Airspace System
NIRS	Noise Integrated Routing System
OAG	Official Airline Guide
PAR	Precision Approach Radar
RACOMS	Radio Line-of-Sight Coverage Mapping System
RAMS	Reorganized ATC Mathematical Simulation
SAR	System Analysis Recording
SDAT	Sector Design Analysis Tool
SIMMOD	A trademark for the FAA’s airport and airspace simulation model
SUA	Special Use Airspace
TAAM	Total Airspace and Airport Modeler
TRACON	Terminal Radar Approach Control
UTC	Coordinated Universal Time
VFR	Visual Flight Rules